



**Mainstream<sup>®</sup>**  
**Conference**

# Safely Switching Gears At 28,000 kph

Ed Van Cise  
NASA Johnson Space Center

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Presentation PET 0:00

40 minutes max for talking, leaving 10 minutes for Q&A.

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## Human Spaceflight Relevance to Asset Management

- Unique, one of a kind asset
- Expensive
  - USD \$150+ billion
- Supported by crewed and uncrewed spacecraft ferrying cargo and crew
- Large and complex systems

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Duration: 1:00

PET: 1:00

How is NASA and the space station relevant at an Asset Management conference? These first few slides are meant to both explain a bit more about ISS but also highlight that there are several similarities to the industries and companies represented at Mainstream. This piece is really a “why you should listen to me” piece.

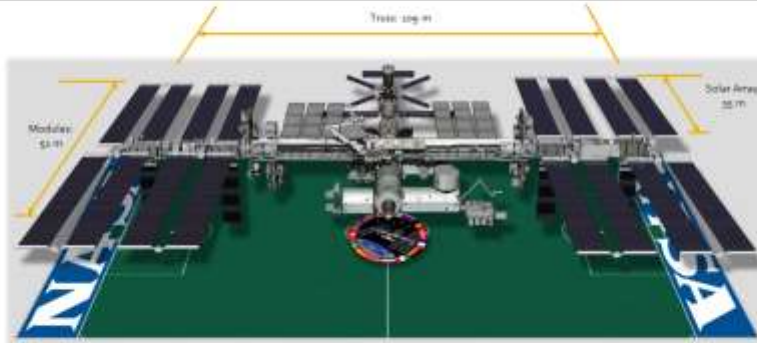
See if this sounds familiar –

The Space Station is a large, unique, and expensive asset that is supported by people and resources from all over the world

Space Station exists to generate profit that's only capable of being created by this unique off-planet asset. In our case, profit does not mean financial profit but rather the generation of new, ground breaking research results that will benefit life on Earth and also assist us in the pursuit of sending people beyond Earth for long durations.

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## Earth's Only Microgravity Research Laboratory



**LARGE, CAPABLE LABORATORY:**  
Mass: 420,000 kg  
Habitable Volume: 308 m<sup>3</sup>  
Solar Power Generation Capability: 84 kW  
Numerous external and internal research platforms

**REMOTE OUTPOST:**  
Altitude: 415 km (250 mi)  
Orbital Speed: 28,000 kph (7.8 km/sec)  
17,500 mph (5 mi/sec)  
Orbital Period: 90 minutes  
(16 sunrises/sunsets per day)



Duration: 2:00

PET: 3:00

A little more detail and information about our asset.

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## Assembling the Assets



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Duration: 4:00

PET: 7:00

Video runs 2:47

Our remote asset wasn't put into Earth orbit as a single unit. We had to build all the pieces at contractor and sub-contractor locations all around the world. Then we had to get that hardware to one of a few launch sites, put them into low Earth orbit, and assemble the space station in orbit. Many of the pieces were not able to be test-fit together on Earth, they came together for the first time in space.

YouTube URL for this movie: [https://youtu.be/\\_OqL\\_GEML64](https://youtu.be/_OqL_GEML64)

Music is free use from <http://www.bensound.com>.

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## Human Spaceflight and Asset Management

- Dispersed infrastructure
  - Multiple launch sites, ground depots, contractor facilities around the globe
  - 5 mission control centers spread around Earth



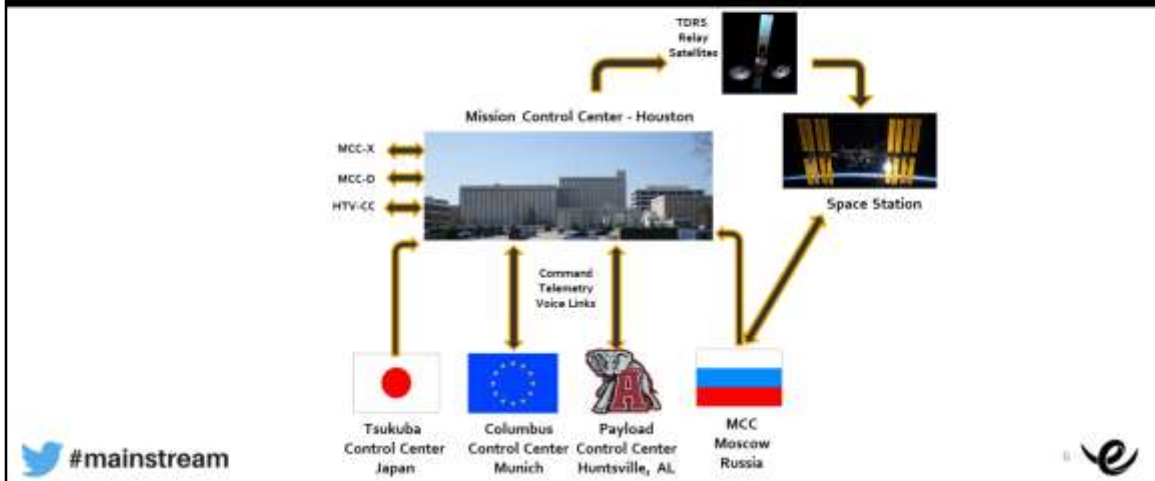
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Duration: 2:00

PET: 9:00

Multiple launch sites, multiple contractors, 5 mission controls – definitely a global mission and global partnership



Duration: 3:00

PET: 12:00

5 control rooms support Space Station – in Germany, Russia, Japan, and 2 in the US. Each is responsible for its own country's components. In the US, we have 1 control center responsible for the US modules to keep them running and keep the crew alive. That's what we do in Houston. The other US control center in Huntsville, Alabama, is responsible for all of NASA research and experiments. They work with the crew to accomplish the science while in Houston we keep the lights on and the crew breathing.

Focusing a bit more on MCC-Houston, a little more detail about how nearly everything funnels into/through/from Houston to get to the ISS. Yet we also have dissimilar redundancy via MCC-Moscow.

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## Mission Control Center – Houston FCR-1, est. 1965



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Duration: 2:00

PET: 14:00

Houston is also the Lead Control Center – the buck stops at the Houston Flight Director. Houston Flight is the final authority for real-time operations. Also describe a bit about how the room works, how the various consoles are responsible for different aspects of the mission, all funneling into Flight.



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## Human Spaceflight and Asset Management

- Remote Location
  - 400 km straight up
  - Spare parts are sometimes hard to come by
  - Repair, including shutdowns and turnarounds, can mean conducting one or more dangerous spacewalks



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Duration: 1:00

PET: 15:00

No such thing as a complete shutdown. Repairs must always be conducted while ensuring the Station can keep the crew alive and safe. Safety is always our number one priority.



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## Human Spaceflight and Asset Management

- Trying to make a 'profit'
  - Unique research and science that can only be conducted off-planet



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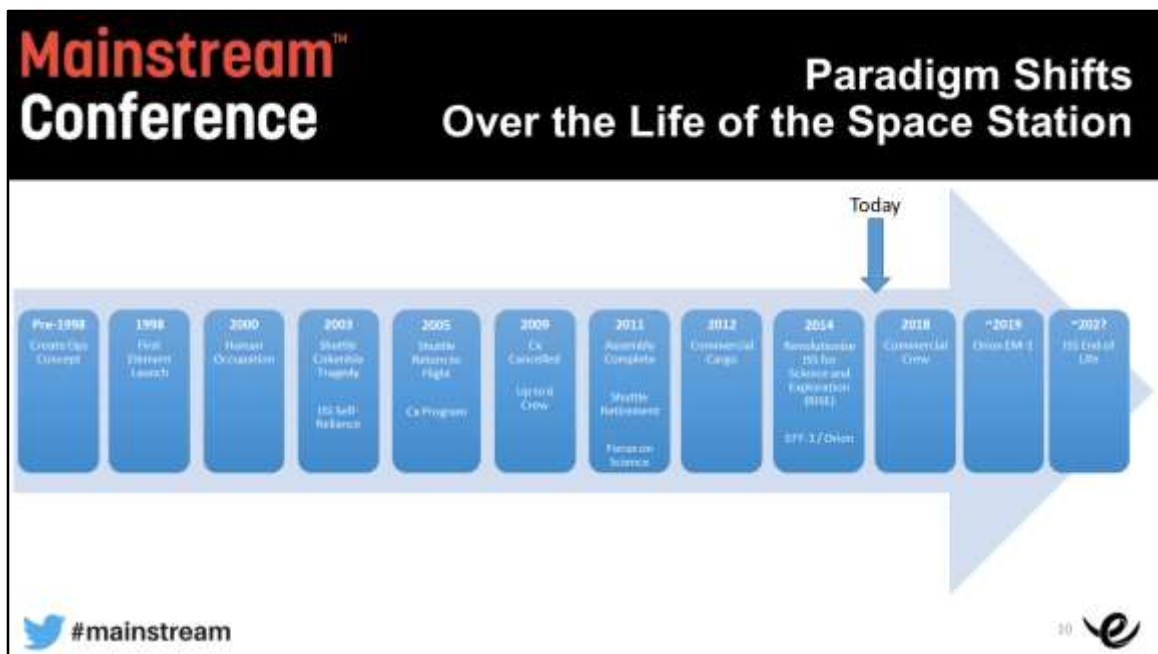
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PET: 19:00

Video source: <https://youtu.be/gv4sOEXrtQ>

Duration: 3:35

Do these situations strike you as similar to the environment you deal with in your industries? From my experience with Mainstream and other asset management conversations, I think we have a lot in common and a lot we can learn from each other.



Duration: 5:00

PET: 24:00

Space Station has been in orbit since 1998, crew-tended since 2000. It's probably no surprise to you that the mission we started with in 1998, the mission we thought we'd be flying for decades, is nowhere near where we are today. Things have changed. Sometimes we saw the change coming and sometimes we didn't. The same is true for your industries – sometimes you see the paradigms shifting and you try to prepare for them. Sometimes they hit you square in the face and you just have to react. Sometimes they happen and it's only after the fact – maybe years later – you realize what's happened or that you missed an opportunity and your only choice is to scramble to recover.

Here are just a few of the paradigm shifts that have happened since the space station has been in orbit.

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## Shift Happens

- Sometimes you can see it coming and plan for it
  - Creating ISS ConOps, First Element Launch, Human Occupation, Return to Flight, Constellation Program, Increase to 6 crew, Assembly complete, Orion/Exploration Program, ISS End of Life
- Sometimes it is sprung upon you and you have to react to it
  - Columbia tragedy, Constellation cancellation, RISE
- Sometimes you should have seen it coming and now you play catch-up
  - Shuttle retirement and refocus on Science, RISE



"Whenever Frank shifts gears... it's always into park."

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Duration: 2:00

PET: 26:00

We're not perfect and not here to say we are. As much as we try to look ahead and prepare for everything, sometimes we get caught off guard. Sometimes we're so focused on paradigm shifts that we know are coming we stop looking for the unanticipated changes and get caught off guard.

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## “Profit” Changes with Paradigm

- Paradigm shift will often result in asset management philosophy shift
  - Asset Management is crucial in helping utilize your assets in order to optimize profit
  - For Space Station, scientific research is always the 'ultimate profit' but how you get there and the path to success changes
- Examples
  - Columbia tragedy – profit became surviving without regular shuttle resupply
  - Increase to 6 crew – profit became keeping twice as many crew alive and occupied
  - Constellation cancellation, shuttle retirement – profit became international relationships that relied solely on other countries to provide access to the Space Station
  - Focus on science – profit shifted 'over night' from assembly to producing useful science at high rates
  - RISE – profit became more than just performing science but streamlining access to the laboratory, conducting more complex research, and using Space Station as an exploration test bed
  - Commercial crew – profit is now relearning old skills of launching spacecraft from US soil while ALSO continuing to produce excellent scientific results from Space Station



Duration: 3:00

PET: 29:00

As you adjust processes, techniques, and approaches with a paradigm shift, be sure to stop and assess your definition of 'profit.' Did it change too?

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## Managing Space Station Paradigm Shifts

- Foundations of Flight Operations
  - Essential Individual Qualities: *Discipline, Competence, Confidence, Responsibility, Toughness, Teamwork, Vigilance*
  - We may find ourselves in a role where performance has ultimate consequences
  - Greatest error is to not give our best effort in everything
- Core Values
  - “All in,” innovative, optimistic, responsible, operate with integrity and honor
- Clarity of definition of ‘profit’
- Leadership from top down and from bottom up
  - Relies heavily on defining and utilizing non-changing foundation/values



1. To instill within ourselves these qualities essential to professional excellence
  - *Discipline*: Doing what is right as well as to lead, knowing that we must master ourselves before we can master our tools.
  - *Competence*: There, being no substitute for total preparation and complete dedication, for flight will not tolerate the careless or inefficient.
  - *Confidence*: Believing in ourselves as well as others, knowing that we must master fear and hesitation before we can succeed.
  - *Responsibility*: Realizing that it cannot be shifted to others, for it belongs to each of us, we must answer for what we do as well as do.
  - *Toughness*: Taking a stand where we must, and to try again and again, even if it means following a more difficult path.
  - *Teamwork*: Respecting and using the abilities of others, realizing that we each toward a common goal, for success depends upon the efforts of all.
  - *Vigilance*: Being always attentive to the dangers of flight, never accepting shortcuts as a substitute for rigor in everything we do.
2. To always be aware that, suddenly and unexpectedly, we may find ourselves in a role where our performance has ultimate consequences.
3. To recognize that the greatest error is not to have tried and failed, but that, in the trying, we do not give it our best effort.



Duration: 3:00

PET: 32:00

FOD has had to shift and change over time as the profit/end-game has shifted. While we shift and change, there are some things we work incredibly hard to ensure never change (Foundations, Core Values). We’re also regularly seeking clarity on what’s currently our “profit.” For our organization, there can be multiple ‘profits’ at once – for ISS it’s research, for commercial crew it’s contract success (financial profit), for Orion & Exploration – it’s enabling beyond Earth missions.

### ISS Examples

Shift Duty Officer to ACE flight controllers to GEMINI flight controllers to Operator/Specialist/Instructor

- Not putting everything on the table for change
  - “We’ve always done it that way and been successful” points to the past but may be irrelevant for the future
  - Past is a useful benchmark but continue to assess it against the new definition of ‘profit’
  - Clearly define the non-changeables (foundation/values)
- Lack of management clarity and dedication
  - Paradigm shift often means culture change – takes time, constant leadership, and priority at all leadership levels
  - Even months after a roll-out, teams will go back to the ‘old way of doing things’ if it appears management is no longer serious or committed
- Not getting full cross-organizational buy-in
  - The entire organization/company must be “all in”
  - Lack of commitment, or worse – active resistance – will significantly handicap efforts to make swift progress



Duration: 3:00

PET: 35:00

### Not putting everything on the table for change

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Past is a useful benchmark but continue to assess it against the new definition of ‘profit’

Clearly define the non-changeables (foundation/values)

### Lack of management clarity and dedication

Paradigm shift often means culture change – takes time, constant leadership, and priority at all leadership levels

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### Not getting full cross-organizational buy-in

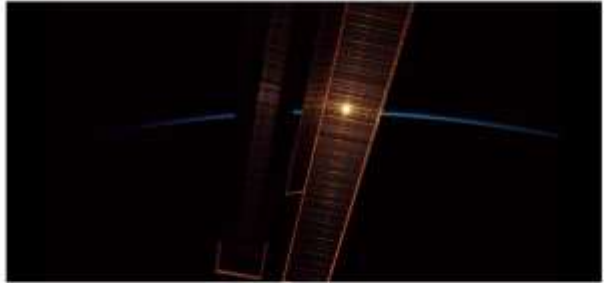
The entire organization/company must be “all in”

Lack of commitment, or worse – active resistance – will significantly handicap efforts to make swift progress

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## Shifting Gears at 28,000 kph

- Look ahead – try to predict paradigm shifts
- Actively look for areas of resistance to change
- Continually reevaluate 'profit'
- Know and protect your foundation
- Grow leaders at all levels



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Duration: 3:00

PET: 38:00

Look ahead – try to predict paradigm shifts

Strategize on potential failures that could drive unforeseen changes

Example: stand down on Space Shuttle flights for multiple years

Continually reevaluate 'profit'

If you're producing a lot of something but that something is no longer needed then you're really just producing waste and not profiting

Will current techniques, processes, strategies work to produce the new 'profit?' Let the answer to this question drive process/technique changes

Expect to change your asset management philosophies to keep up with a change in 'profit' definition

Know your foundation

What values are unalterable?

Winds of changing paradigms can blow you all over the place. Establish in advance the things/values that you will not alter even as profit changes over time

Grow leaders at all levels



Engage those leaders in development of the paradigm shifts and engage them in committing to their implementation

Actively look for areas of resistance to change

Do not assume 'they will get onboard'

Make sure everyone understands the reason and motivation for the change

Make leadership changes if necessary

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## Contact Info and Websites


### **How to contact me:**


Ed Van Cise

[edward.a.vancise@nasa.gov](mailto:edward.a.vancise@nasa.gov)

+1 281 483 9170

 @NASA

 @Space\_Station

 @Carbon\_Flight

 cflight78



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